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By [signature]

PATENT

Attorney Docket No. 023071-553

OFFICIAL

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	
MICHAEL D. DOYLE et al.	Examiner. D. Dinh
Application No.: 08/324,443	Art Unit: 2317
Filed: 10/17/94	**DECLARATION OF MICHAEL D. DOYLE UNDER RULE 131**
For: EMBEDDED PROGRAM OBJECTS IN DISTRIBUTED HYPERMEDIA SYSTEMS	

JAN 08 1997

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

I, MICHAEL D. DOYLE, hereby declare that:

1. I am a co-inventor of the subject matter disclosed and claimed in U.S. Patent Application No. 08/324,443.

2. The subject matter claimed in the above patent application was reduced to practice in this country prior to October, 1994, the publication date of the cited reference entitled "Mosaic and the World-Wide Web" by Vetter.

3. The reduction to practice of the claimed invention is evidenced by ATTACHMENT A, which is a transcript of the audio portion and still photographs of a video tape presented to an audience of scientists prior to October, 1994.

4. As stated in ATTACHMENT A, starting at the bottom of page 2, interface and control software had been developed that allows the embedding of a visualization application within a Mosaic document. As is apparent from the photographs, the object is displayed and processed within the browser-controlled window. The visualization application is external to the hypermedia document displayed by the browser.

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MICHAEL D. DOYLE et al.
Application No.: 08/324,443
Page 2

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I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Dated: 1-2-97, 1997.

MICHAEL D. DOYLE

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1026 FOIA Exhibit 3E 080

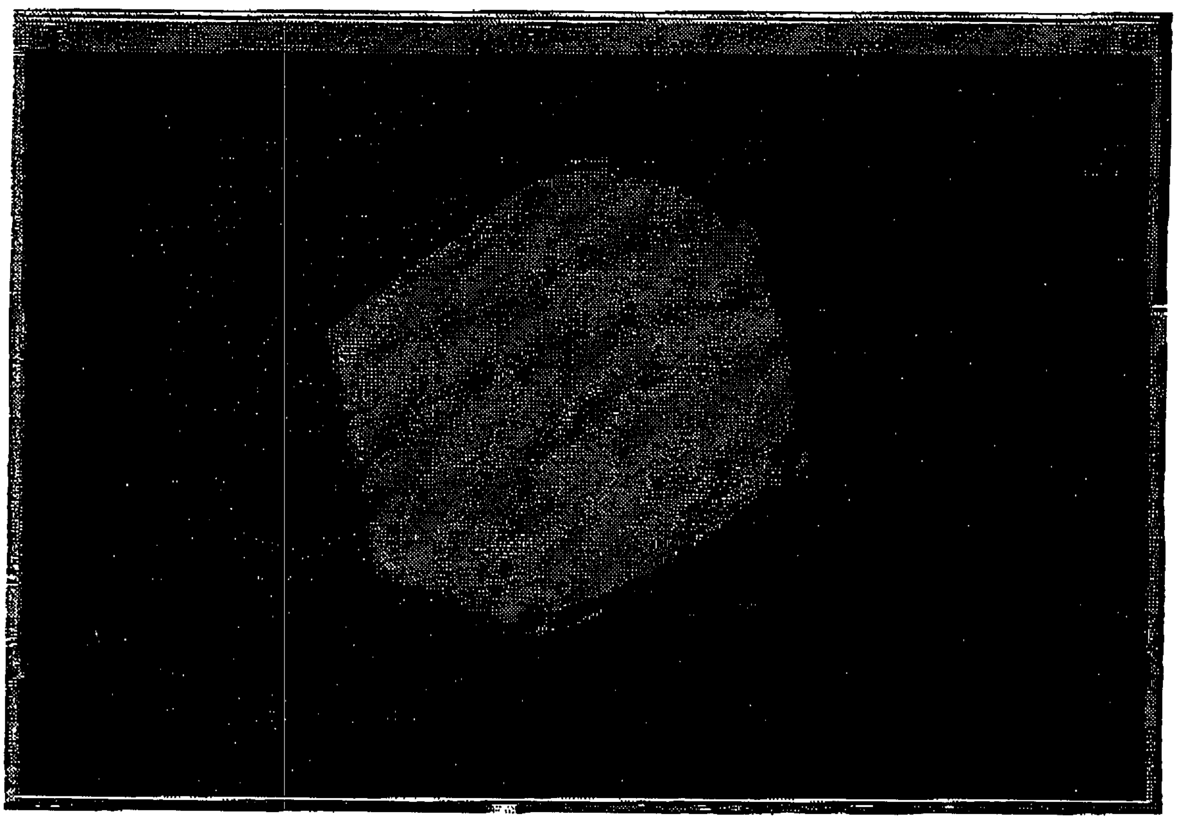
Attachment "A"

M.D. Doyle, et. al., ***The Virtual Embryo: VR Applications in Human Developmental Anatomy,*** presented at "Medicine Meets Virtual Reality II, Interactive Technology and Healthcare: Visionary Applications for Simulation, Visualization & Robotics," sponsored by the UCSD School of Medicine and the Advanced Projects Research Agency, San Diego, CA, **January 27, 1994**.

Video Presentation Transcript:

This is a status report of some of the work that's been accomplished during the first years of the Visible Embryo Project.

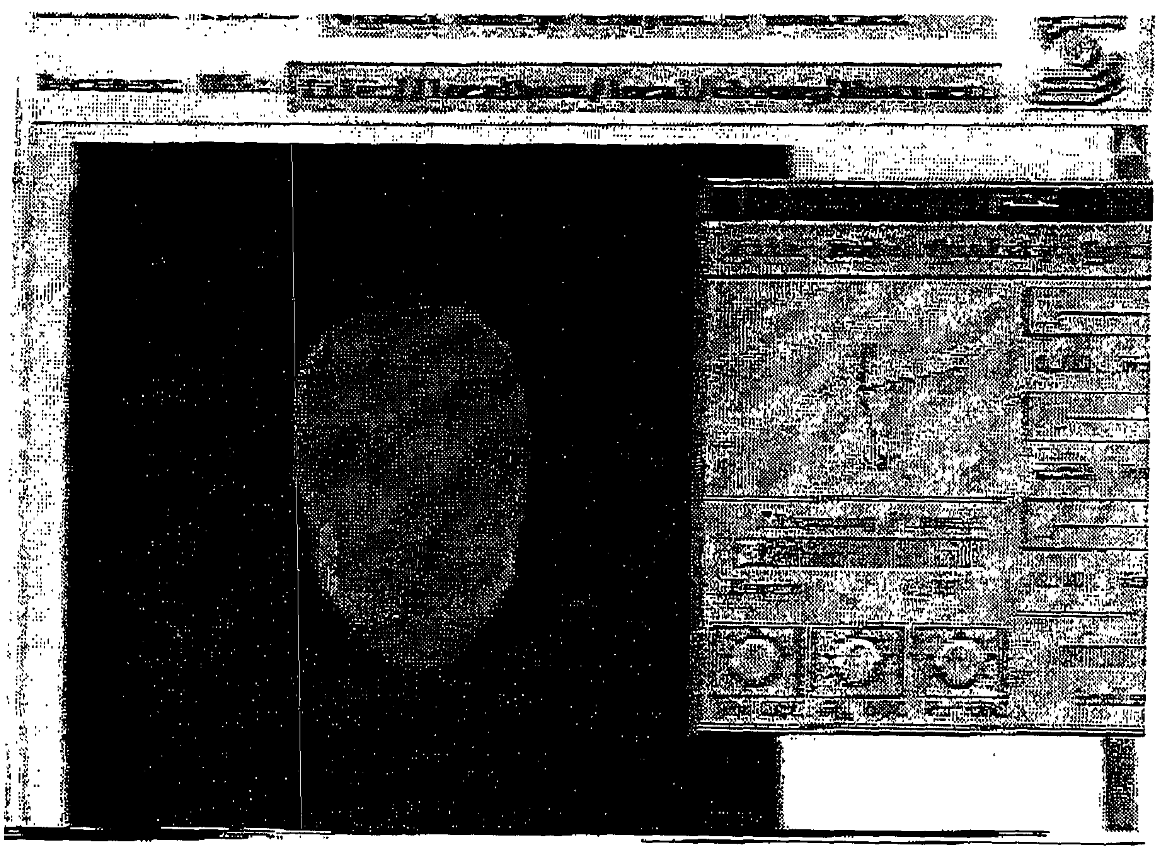
One of our first tasks was to develop some volume visualization software that we could use for imaging and analysis of the embryo reconstructions that we planned to create during the full term of the embryo project. One thing that was an absolute requirement was that this software be able to distribute its computational load across a network of graphics computers that weren't necessarily all in the same place. Basically we wanted to be able to have computers that could be all over the country connected by high -speed networking, able to contribute to a computation of three-dimensional datasets.



What you see here is a package called "VIS," which was developed in our group, for three-dimensional volume visualization. This is a very portable

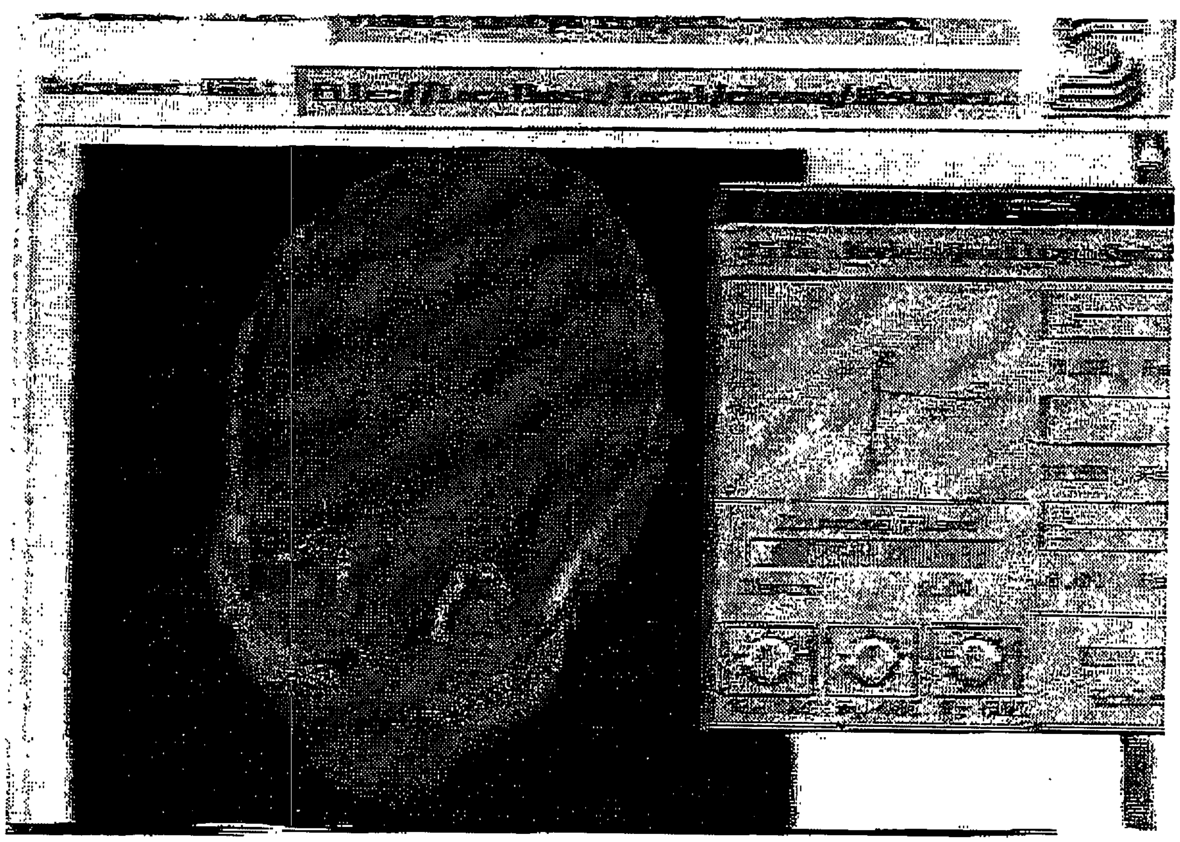
package that has been generated using as generic code as possible, although this particular image that you see here is running on a Silicon Graphics Reality Engine II, which is optimized for volume visualization. We need to use that kind of high-speed optimization to accomplish the real-time interactivity that we need to accomplish for this project. And as you see, as this rotates, and it starts rotating faster and faster, only a very powerful graphics - basically a graphics supercomputer - can accomplish this much computation on a three dimensional dataset. One of our goals is to allow anybody on the Internet with a very low-level access workstation to accomplish this kind of interactivity through their network connection, and the way that we do that is through a client-server architecture where we have a very powerful server computer accessed by a very low-end client machine.

We decided early on to use NCSA's Mosaic program and the World Wide Web to integrate access to this system. One problem with Mosaic is, as it exists today, is that the images within Mosaic are typically static or passive-playback images.



What you see here is an enhancement that we've created to the Mosaic interface and control software that allows the embedding of a dynamic real-time

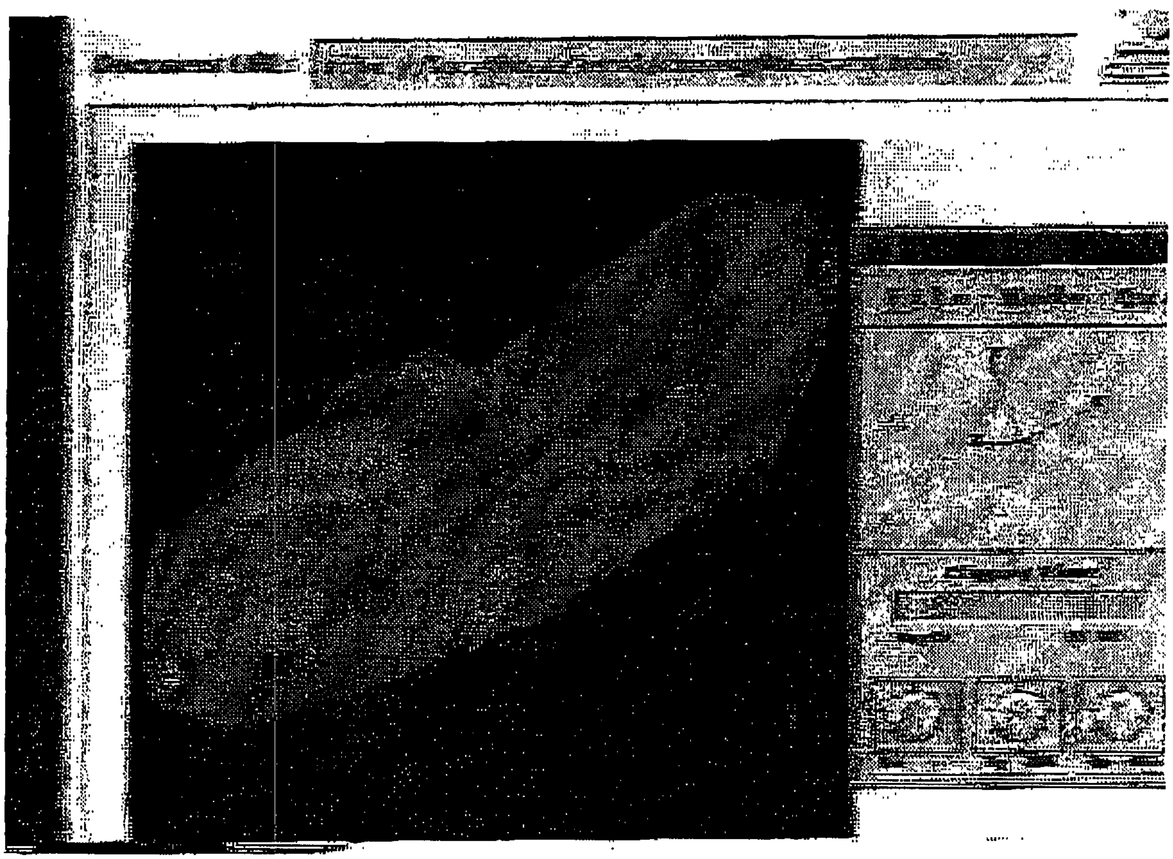
visualization application within a Mosaic document. You see a head, a volume MRI model of a human head, that's being rotated in real-time interactively by the viewer. You see a little panel to the right which is, it's a control panel that's popped up - it's really external to Mosaic itself but it can talk to the internal control programs that drive the Mosaic client - and allow you to interactively control the display from within Mosaic. This is actually controlling the volume visualization software that you just saw a few minutes ago.
By moving around the controls in the control panel we can do things like rotate, we can control slices through the dataset, and so on. As you can see, there's rotation in x, y, and z planes. We can also compute arbitrary oblique sections through the data and look at the internal anatomy. Here we can see the brain of this individual; we can rotate and view that section of the dataset from a variety of vantage points. There are zooming capabilities that allow us to zoom up on the data or zoom back to look at things in more or less detail, and you can see here that once zoomed, we're moving our cutting plane down through the dataset and looking at more and more inferior levels.



Normally graphics in Mosaic are static, as I said, but this embedding of graphic applications within Mosaic is really going to form the basis of how we integrate information access through the Visible Embryo Project. What you are about to

see is our prototype system of a Visible Embryo Mosaic document that has embedded realtime visualizations within it.

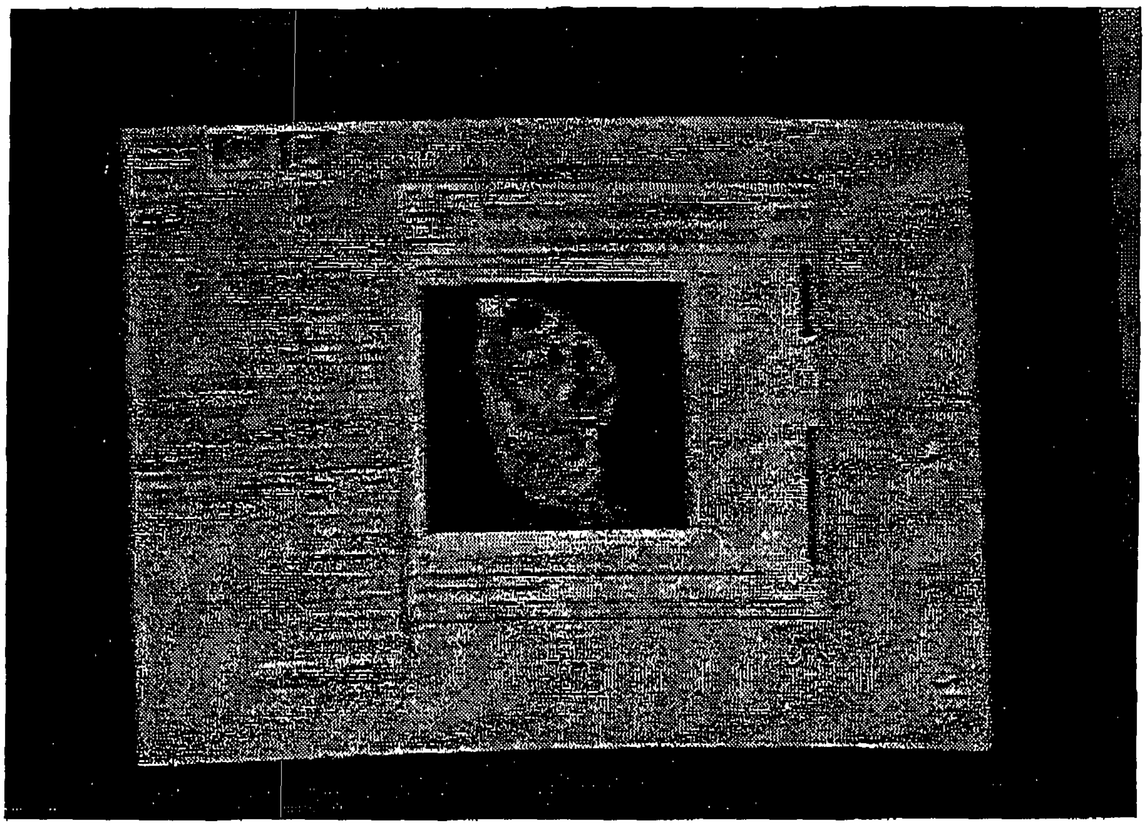
We just loaded the Visible Embryo Mosaic page, the system is about to scroll down this page - it is an abstract about the Visible Embryo Project - and then we see a window. It looks like a static image just like is normally found within the World Wide Web databases that you can access today through Mosaic, but you can see that suddenly, by moving controls on the control panel, we can zoom in and see that this is a reconstruction of a seven week old human embryo. This is a reconstruction from approximately 2900 serial cross sections of an embryo sectioned about in the 1930's. It's part of the Carnegie Collection of Human Embryology.



We're looking at this in volume visualization mode, we can rotate the embryo around, we can see internal structures, neurological structures; just in the lower abdomen area, we can see the liver, the arms are very evident - so we are actually looking through the dataset. We can also slice through this dataset obliquely, and look at the internal anatomy that way as well. We can load a volume visualization table that allows us to interactively enter tissue characteristic numbers that control the translucency, transparency, or opacity of various ranges of voxal intensity. And what we've done now is we've made the

exterior of the embryo a little more opaque so that as we rotate around with an oblique cutting plane we can see the difference between the cutting plane and the exterior of the embryo a little better. So now we're looking, slicing - we've rotated the embryo to an inferior view and we're looking up at the embryo from below. And we can see, we've just gone through the heart region, we're going through the liver, we're moving inferiorly and we start to get to an area where we can see the herniated gut.

Now the real key to all of this is that these are embedded visualizations. We're actually creating documents that are - I guess you'd call them currently compound documents where you have the traditional type of information, but you've also got, within that document, links to the raw data rather than just pictures generated from data. This allows you to tie together representations of data with the actual data themselves as well as with notes and different kinds of descriptive textual information based on that data.

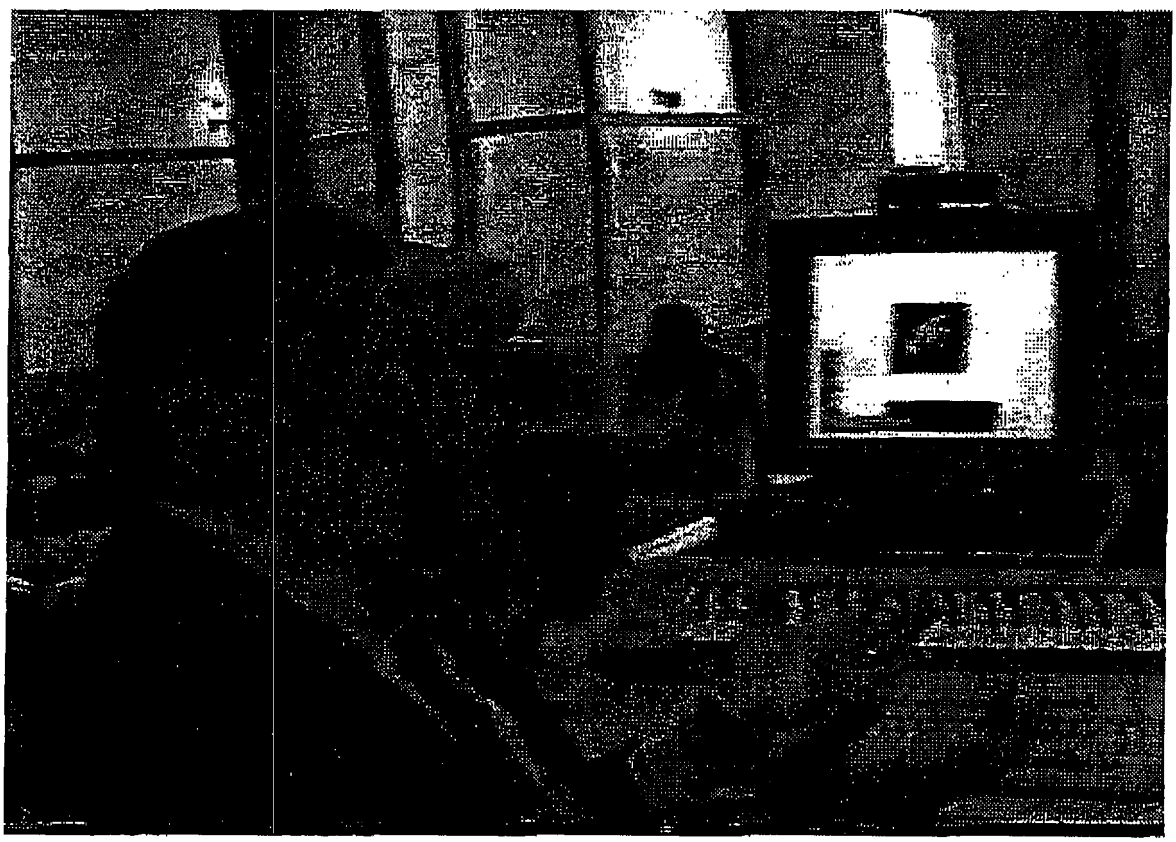


Our basic objective here is really to create what we're calling a national meta-center which is going to be a computational resource for the entire nation that allows people interested in many different areas, including developmental biology, also multi-dimensional imaging and high-speed networking, and parallel computing. All these people can access this database. And the parallel

nature of the computation that's taking place is invisible to the user. They log in through a Mosaic window, and that window is giving them very high-performance control of interactive visualizations of datasets. By scrolling the window, we can see that this is actually embedded within the Mosaic document.

During a recent demonstration of this technology at the corporate briefing center at Silicon Graphics Corporation in Mountain View, California, I discussed some of the implications of this technology for researchers of human genetics.

"We're also looking at using these models as a basis for creating three-dimensional maps of gene expression, which is a way to correlate the findings of the Human Genome project within a context that everyone uses. It sort of sets up a standard space within which everybody can report their findings, so that you can finally have some way of comparing studies that happen in different laboratories.



If you're studying the three-dimensional distribution of gene expression of a gene relating to heart development, what you do now is you have a little fluorescent marker that glows under an ultraviolet light, and you use confocal

microscopy to develop a three-dimensional model of it, and then you say, well, it's on here and it's on there and it's on there and you try to describe it in anatomical terms but it is a qualitative description, right?.

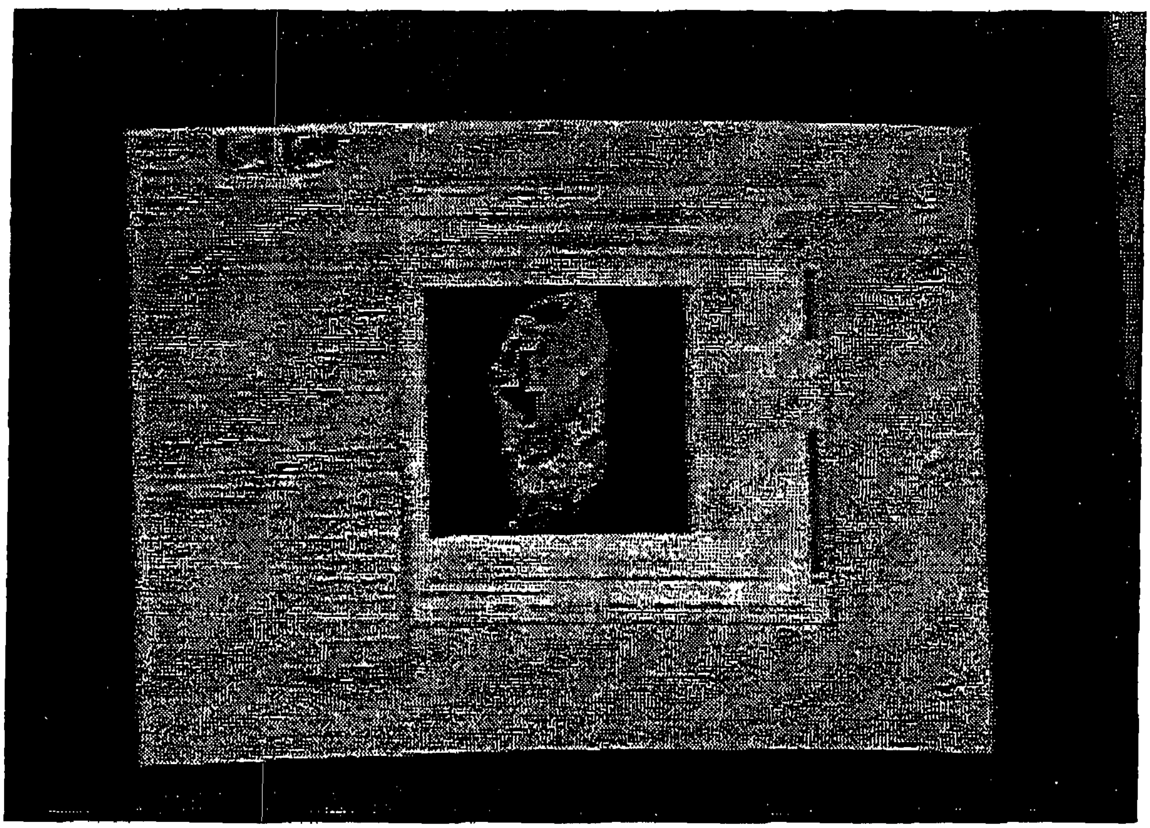
But here there would be a standard anatomy space that people could use to describe their findings so that they could, rather than say, yeah, we saw five different studies that said that this was expressed at the bifurcation of the aorta with the Common Carotid artery - you don't have to do in terms of verbal descriptions, you can do it in terms of a true measurable Cartesian coordinate system.

If you take your current version of Mosaic, the kind that is accessible for free through the Internet today, and log onto our home page of the Visible Embryo Project, what you'll see is a series of multi-media documents that basically give you information about the status of the Visible Embryo Project and the status of our current proposal development efforts. You'll be able to load MPEG movies of visualizations of human embryos, as you can see here.

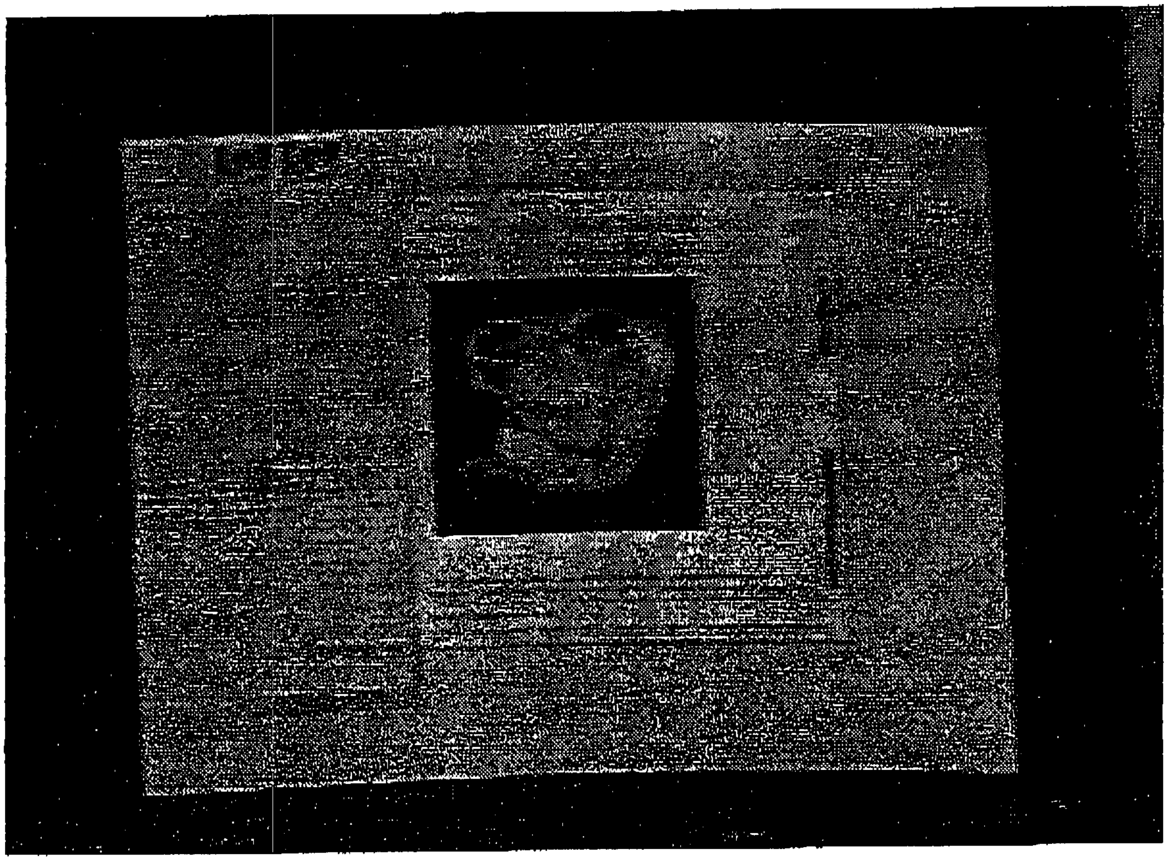
One thing you should keep in mind is that this little MPEG movie is just a canned movie, it's not interactive. Once you hit Play it just goes and it plays and then it goes away, but you can't stop it and interact with it, and rotate that embryo, for instance, to different vantage points.

Also available is an image that shows some of the early work, some screen shots representing the volume visualization tool current as of about last summer. We've come much farther and in fact a lot of the video that you saw earlier in this presentation shows you the current status of this volume visualization package. Last summer, that imaging package was separate from Mosaic, as you see it's off to the right, and Mosaic could just call it but couldn't actually embed visualizations. Now, everything is tied together into a single multi-media document.

You'll also see articles that relate to the Visible Embryo Project. This project has been going on for several years now, mostly on the coattails of other research projects, collaborators funding it wherever they could find the money. But already a significant body of literature is starting to be built up around this project.



Of course, in the very near future, you'll be able to log on through an enhanced version of Mosaic. **We're working together with the National Center for Supercomputing Applications on enhancing the standard release of Mosaic to allow these capabilities.** And you'll be able to access interactive dynamic visualizations that are being served by a network of high-end supercomputers across the country. Even if you're only accessing the system with a machine like a Macintosh or PC, you'll still be able to access the power of these supercomputers from your own location.



What I've attempted to demonstrate in the last several minutes in this presentation is that there's been a considerable amount of work already done in this project that we call the Visible Embryo Project. Many collaborators across the country have worked together to create a set of enabling technologies to allow this project to accomplish its goals. The Visible Embryo Project represents an effort to serve the needs of both the biology community as well as the information science community, in that we are attempting through current applications in information technology to break through barriers that have prevented biological researchers from asking and answering questions about the most fundamental mechanisms of human growth and development. We're also creating a technology development testbed for the information sciences that will allow researchers to push the envelope, so to speak, of information technologies to their very limits.

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We would like to audio/video tape your presentation at **Medicine Meets Virtual Reality II: Interactive Technology and Healthcare**, January 27-30, 1994.

Audio and video tapes will be available for immediate distribution to attendees and will be marketed and sold after the conference. Your colleagues will be able to benefit from your remarks by listening to cassettes and viewing tapes whether or not they were in attendance. The tapes will be copyrighted and marketed under Title 17 of the U.S. Code or other law as may be enacted, and all rights to royalties, if any, in conjunction with cassette sales shall hereby be assigned to Medicine Meets Virtual Reality. This agreement does not preclude the publication by you of your paper, speech or comments at any time and in any format.

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CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that the following Response After Final and Declaration of Michael D. Doyle Under Rule 131, in re Application of Doyle et al., Serial No. 08/324,443, filed October 17, 1994, for EMBEDDED PROGRAM OBJECTS IN DISTRIBUTED HYPERMEDIA SYSTEMS is being facsimile transmitted to the Patent and Trademark Office on the date shown below.

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